

E O L E Project

EVALUATION OF THE PROBABILITIES OF COLLISION BETWEEN BALLOONS

AND AIRPLANES

FINAL REPORT

by Yves Le Borgne

Centre National d'Etudes Spatiales
Centre Spatial de Bretigny
Division Mathematiques & Traitement
Departement Calculateurs

From: "Projet EOLE. Evaluation des Probabilites de Collision
entre Ballons et Avions. Rapport final", by Yves Le
Borgne. CNES, Jan. 1969 (YLB/MMR/9.022/MT/CB).
[Appendices not translated].

Translated by
Belov & Associates
for
N.A.S.A. GSFC Library
Contract NAS 5-10888
Item no. 10888-046
February 1970

FACILITY FORM 602

<u>N70-73716</u>	
(ACCESSION NUMBER)	(THRU)
<u>9</u>	<u>None</u>
(PAGES)	(CODE)
<u>CR-110110</u>	
(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)



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Project E O L E

EVALUATION OF THE PROBABILITIES OF COLLISION BETWEEN BALLOONS AND AIRPLANES

-Final Report-

Note 8.190 MT/CB, titled: "Final report of phase I", had presented:

- analyses of the problem,
- elaboration of the mathematical model,
- study of the traffic in the southern hemisphere,
- statistical data on airplanes and balloons,
- elaboration of a methodive calculation.

This report has received the approval of interested persons, in particular, at the Secretariat General and the Civil Aviation.

Phase II of the study has then been completed.

This report presents the results of it.

I. PROGRAMMING ON 360 ORDINATOR

The calculation program has been completed in accordance with the structure indicated on page 18 and 19 of the end of phase I.

One will find, attached, a reproduction of the issued list of execution of the program on the 360/65 of C.N.E.S.

Attachment I: list of instructions of the calculation program

Attachment II: list of data cards.

- types of airplanes
- critical frontal areas,
- flight profiles,
- table B: characteristics of stages
- table A: number of flight per stage.

Attachment III: results for a given distribution of balloons.

II - PARAMETERS

The probabilities and the corresponding risks have been calculated as a function of 2 parameters:

- the distribution of the balloons,
- the critical frontal area.

a) Distribution of the balloons

In the hypothesis of a sending of 500 balloons, it has been considered that one would have at the maximum 100 balloons simultaneously in the space EA.

These balloons will be at 200 mb * (FL = 380) or at 300 mb (FL = 300) or uniformly distributed between these two levels. From whence the three distributions: (next page)

FL \	300	320	340	360	380
R1	100	0	0	0	0
R2	20	20	20	20	20
R3	0	0	0	0	100

b) Critical frontal area

Three critical frontal areas are considered:

AF1 = Airplane + Balloon + Nacelle

AF2 = Airplane + Nacelle

AF3 = Frontal Glass Casing + Nacelle

Airplane						
Avion \	B707	DC8	B727	DC9	Comet	Caravelle
AF1	1040	1040	820	700	800	813
AF2	544	539	403	328	427	391
AF3	27,2	27,2	25,5	25,5	25	24

III. RESULTS

1966 T = Number of hours of flight in EA in March 1966: 5,062 hours

p = Probabilities of having at least one collision in a month of the year considered

r = risk for 100,000 hours of flight.

(next page)

AF R	A F 1		A F 2		A F 3	
	P	r	P	r	P	r
R1 300 mb	0,00052	0,010	0,00027	0,0053	0,000014	0,00027
R2	0,0022	0,043	0,0011	0,022	0,000057	0,0011
R3 200 mb	0,0028	0,055	0,0015	0,029	0,000073	0,0014

1968 T = 10,985 hours in March 1968

AF R	A F 1		A F 2		A F 3	
	P	r	P	r	P	r
R1	0,0053	0,049	0,0026	0,024	0,00017	0,0016
R2	0,0044	0,040	0,0022	0,020	0,00013	0,0011
R3	0,0037	0,030	0,0019	0,018	0,000097	0,00089

The number of hours of flight has doubled between 1966 and 1968: this is principally due to the introduction of the B727 and DC9 on the interior Australian lines.

IV. ANALYSIS OF THE RESULTS

Before any analysis, it is necessary to remember that the study is a statistical study and as such, the results do not have an absolute character. They are for a good part a function of the hypotheses set forth in the significant figures are only given because they were available; only the order of magnitude have a significance.

Finally a probability of collision of 10^{-4} , doesn't exclude a collision on the first day of operation, from which arose a necessity of making balloons presenting the minimum risk in case of collision. Its politics which adopted the C.N.E.S.

This standing, one can offer the following remarks. One remembers the risk of accidents for 100,000 hours of flight in 1966:

- in the world: 0.27
- in Australia: 0.69

Influence of the distribution of the balloons

In 1966, the distribution R3 presented less risk than in 1968: this holds to the fact pointed out above: introduction of jet airplanes on the interior Australian lines.

But, beginning with 1968, this fact will remain: the distribution of the balloons at 200 mb presents less risk than that at 300 mb.

Influence of the frontal area considered

If a collision between all of an airplane with all of a balloon--nacelle assembly has a rather strong probability: 0.0037 in one month (at 200 mb), the probability of collision of a nacelle with the glass casing of an airplane is on the order of 10^{-4} , which makes a risk for 100,000 h of flights on the order of 0.001 in comparison with the risks of references already cited.

This is due to the fact that an airplane such as the DC8 has a wing span of 44m for a fuselage diameter of 4m, while the glass casing only represents, in frontal projection, a surface of 85.6 dm^2 .

Influence of non-regular flights (Charters)

This problem had remained in suspense. It has been taken up on the request of the SGAC. It has been resolved thanks to the active cooperation of the Operations division of the UTA.

It results from the studies that there were in 1966: 147 non-regular jet flights entering or leaving Austrailia (there were 142 in 1967).

It suffices to say that the Qantas Company has assured itself alone, in 1966, more than 5,000 regular flights to conclude that the influence of non-regular flights is negligible on the results of our estimations.

Influence of the year

It has already been seen that the results are a function of the traffic structure and that from 1966 to 1968, if the risk for 100,000 h of flights hasn't noticeably developed, the probability of collision has followed the doubling of the number of flight hours.

But the zone considered in the study has experienced a measure development of air traffic.

Between 1965 and 1970: Transpacific: volume X by 6

Far East/Austrailia: volume X by 3

Pacific Islands: volume X by 5

(Referrence: the IATA in the year 1970. Page 29).

When the Eole experiment takes place in December 1970, one will be able to expect a traffic double that of 1968, but with the same traffic structure. (the super transports such as the B 747 will enter service in 1971).

From which arises a risk for 100,000 h of flight which will remain on the order

of 0.001, and a collision probability in one month on the order of 0.0003 (collision: nacelle--last covering).

Influence of the geographic zone

The present study was limited to the EA area (from Djakarta to Honolulu and covers Austrailia, New Zealand).

It doesn't seem useful (although there are only flight statistics by stage) to re-do the same calculations for other zones such as: South America and South Africa where the density of jet traffic is much less than in EA.